Oil Shocks and U.S. External Adjustment

Preliminary Results

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Motivation

Policymakers have focused a great deal of attention on the expanding U.S. trade deficit

Many observers concerned that a trade balance correction may entail a large dollar depreciation, higher interest rates and a large recession

Discussion on U.S. trade deficit has largely ignored the shocks that precipitated the deficit and how they are likely to unwind

Here we attempt to quantify the contribution of higher oil prices to the widening of the U.S. trade deficit and the implications for long-run adjustment of the exchange rate and oil and non-oil trade flows

Methodology

We construct simulations using a multi-country SDGE model (SIGMA)

Each country specializes in the production of one good, an imperfect substitute for the goods produced in other countries.

Typical structure of open-economy macro models augmented by the introduction of oil

Oil serves both as an input into the production function of firms, and into the consumption basket of households

Individual country blocks have local oil endowments and can trade both oil and the locally-produced good

A rest-of-the world country block is the residual oil supplier

Methodology

For this analysis SIGMA incorporate four country blocks: U.S., Canada, Euro Area, and a Rest-of-the-World block

Country coverage is chosen only partly for importance in U.S. trade

We want to contrast the reaction to oil shocks of economies with considerably different features:

- Canada is a net oil exporter
- The U.S. is a net importer but has a large oil endowment
- The euro area is a net importer and has no oil endowment

Methodology

The way in which oil enters our model follows important earlier work by Backus and Crucini (1998).

The main difference relative to the setup in Backus and Crucini (1998) is our departure from their complete market setting across country blocks.

Under incomplete markets oil price shocks can exert considerable wealth effects that depend importantly on a country's energy endowment.

We assume a CES production function and also allow for costs of changing the energy share.

Simulation

oil price rises exogenously by roughly 100 percent in logarithmic percentage terms over the period from 2004q1 till 2006q2.

The oil price increases are chosen to mimic the actual pattern of oil price movements.

In our model, the oil price hikes are introduced as a sequence of shocks that agents perceive as permanent; nevertheless, at each date agents expect no future price hikes, and hence are continually surprised as prices rise through 2006-Q2.

In future periods, agents expect that prices will remain at their current (2006-Q2) elevated level.

Results: Implications of Higher Oil Prices since 2003

United States

A 2 ppt decline in the trade balance/GDP ratio. A reduction in oil imports is the main force leading to future adjustment.

Results for Canada

Higher oil export revenues account for roughly a 3 ppt improvement in the trade balance/GDP ratio. A 10% improvement in the non-oil terms of trade and an associated temporary improvement in the non-oil trade balance due to J-curve effects. An expansion in non-oil imports and a reduction in non-oil exports are the main contributors to future adjustment.

Results: Implications of Higher Oil Prices since 2003

Results for euro area

A 2 ppt decline in the trade balance/GDP ratio. The forces contributing to future adjustment are both a contraction in oil imports, and an expansion in net non-oil exports stimulated by a worsening of the non-oil terms of trade.

Specification Issues

Monetary policy, Oil Substitution Elasticity, and Oil Taxes, are all important factors in determining the quantitative effects of oil shocks.

Households

Households maximize

$$\mathbb{E}_t \sum_{j=0}^{\infty} \beta^j \left\{ \frac{1}{1-\sigma} \left(C_{t+j} - \varkappa \frac{\bar{C}_{t+j-1}}{\zeta} \right)^{1-\sigma} + \frac{\chi_0}{1-\chi} (1 - N_{t+j})^{1-\chi} \right\}$$

by choosing C_{t+j}, N_{t+j}, W_{t+j}, I_{t+j}, K_{t+j}, B_{Dt+1} and B_{Ft+1}, subject to:

$$P_{Ct}C_t + P_{It}I_t + \int_s \xi_{t,t+1} B_{Dt+1} - B_{Dt} + \frac{e_t P^*_{Bt} B_{Ft+1}}{\phi_{bt}} - e_t B_{Ft}$$
$$= (1 - \tau_N) W_t N_t + \Gamma_t + TR_t - T_t + (1 - \tau_K) R_{Kt} K_t$$
$$-W_t \frac{\xi_{DW}}{2} \left(\frac{\frac{W_t}{W_{t-1}}}{\frac{W_{t-1}}{W_{t-2}}} + 1 \right)^2 - W_t \frac{\xi_{LW}}{2} \left(\frac{W_t}{W_{t-1}} - 1 \right)^2 + P_{It} \tau_K \delta K_t - P_{Dt} \phi_{It}$$

and subject to the law of motion for capital and firms' labor demand schedule.

Firms

- There are fours types of producers in each country: intermediate-goods producers, oil distributors, producers of the aggregate domestic good, and goods distributors.

- Producers of the intermediate-goods are monopolistically competitive and set prices in Rotemberg-style contracts. They rent capital and labor from households. They purchase oil inputs from oil distributors.

- Oil distributors purchase oil from domestic and foreign households (if necessary) and resell it to firms.

- Producers of the aggregate domestic good “bundle” the continuum of intermediate goods, and take prices as given in input and product markets.

- Distributors purchase both the domestically-produced good and imported goods, as well as an oil input and resell the final consumption and investment goods to households.

Intermediate Goods Producers

The production technology is given by:

$$Y_t\left(i\right) = \left(\omega_V^{\frac{\rho_y}{1+\rho_y}} V_t(i)^{\frac{1}{1+\rho_y}} + \omega_{OY}{}^{\frac{\rho_y}{1+\rho_y}} (O_t^A(i))^{\frac{1}{1+\rho_y}}\right)^{1+\rho_y},$$

$$V_t\left(i\right) = \left(\omega_K^{\frac{\rho_v}{1+\rho_v}} K_t(i)^{\frac{1}{1+\rho_v}} + \omega_L{}^{\frac{\rho_v}{1+\rho_v}} (L_t(i))^{\frac{1}{1+\rho_v}}\right)^{1+\rho_v}.$$

They sell their output both domestically, to final goods producers, and internationally to foreign goods distributors. At home, demand is given by:

$$Y_{Dt}(i) = \left[\frac{P_{Dt}(i)}{P_{Dt}}\right]^{\frac{-\left(1+\theta_p\right)}{\theta_p}} Y_{Dt}.$$

Abroad, demand is given by

$$X_t^k(i) = \left[\frac{P_{Dt}(i)}{P_{Dt}}\right]^{\frac{-\left(1+\theta_p\right)}{\theta_p}} M_t^k,$$

Intermediate Goods Producers (continued)

Firms choose prices so as to maximize profits given below:

$$\mathbb{E}_t \sum_{j=0}^{\infty} \psi_{t,t+j}^{j} \Bigg\{ \Big(P_{Dt+j}\,(i) - MC_{t+j}\,(i) \Big) \left(Y_{Dt+j}(i) + \sum_{\forall k} X_t^k(i) \right)$$

$$-P_{Dt+j}\,(i)\,\frac{\xi_D}{2} \left(\frac{\frac{P_{Dt+j}(i)}{P_{Dt-1+j}}}{\frac{P_{Dt-1+j}}{P_{Dt-2+j}}} - 1 \right)^2 - P_{Dt+j}\,(i)\,\frac{\xi_L}{2} \left(\frac{P_{Dt+j}\,(i)}{P_{Dt-1+j}} - 1 \right)^2 \Bigg\}.$$

Oil distributors

Oil distributors face the following cost minimization problem:

$$\min_{O_t(i)} \mathbb{E}_t \sum_{j=0}^{\infty} \psi_{t,t+j} \Big\{ (1+\tau_{PO}) P_{Ot} O_{t+j}(i) + \tau_{QO} P_{Dt+j} O_{t+j}(i)$$
$$+ P^A_{Ot+j} \left[O^A_{t+j}(i) - O_{t+j}(i) \left(1 - \frac{\varphi_O}{2} \left(\frac{\frac{O_{t+j}(i)}{Y_{Dt+j}}}{\frac{O_{t+j-1}(i)}{Y_{Dt+j-1}}} - 1 \right)^2 \right) \right] \Big\} \quad (1)$$

Final Goods Producers

Final goods producers simply repackage intermediate goods:

$$Y_{Dt} = \left[\int_0^1 Y_{Dt}(i)^{\frac{1}{1+\theta_p}} di \right]^{1+\theta_p}.$$

The final good is sold at a price P_{Dt},

$$P_{Dt} = \left[\int_0^1 P_{Dt}(i)^{\frac{-1}{\theta_p}} di \right]^{-\theta_p}. \tag{2}$$

Similarly in foreign markets k, foreign aggregators produce:

$$M_t^k = \left[\int_0^1 X_t(i)^{\frac{1}{1+\theta_p}} di \right]^{1+\theta_p}, \tag{3}$$

and sell M_t^k at price P_{Dt}.

Distributors

Consumption goods are produced according to

$$C_t = \left(\omega_C^{\frac{\rho_O}{1+\rho_O}} C_{NEt}^{\frac{1}{1+\rho_O}} + \omega_{OC}^{\frac{\rho_O}{1+\rho_O}} \varphi_{Ot} O_{Ct}^{\frac{1}{1+\rho_O}} \right)^{1+\rho_O},$$

where the non-oil component is given by

$$C_{NEt} = \left(\left(1 - \sum_{\forall k} \omega_{Ck} \right)^{\frac{\rho_c}{1+\rho_c}} C_{Dt+k}^{\frac{1}{1+\rho_c}} + \sum_{\forall k} \varphi_{Ckt} \omega_{Ck}^{\frac{\rho_c}{1+\rho_c}} M_{Ckt}{}^{\frac{1}{1+\rho_c}} \right)^{1+\rho_c}.$$

Distributors (continued)

The adjustment cost term for trade takes the form

$$\varphi_{Ct} = \left[1 - \frac{\varphi_{M_C}}{2} \left(\frac{\frac{M_{Ct}}{C_{Dt}}}{\frac{M_{Ct-1}}{C_{Dt-1}}} - 1 \right)^2 \right].$$

Similarly, the adjustment cost term for the oil input in consumption takes the form

$$\varphi_{Ot} = \left[1 - \frac{\varphi_{O_C}}{2} \left(\frac{\frac{O_{Ct}}{C_{Dt}}}{\frac{O_{Ct-1}}{C_{Dt-1}}} - 1 \right)^2 \right].$$

The Government

Monetary policy takes the form

$$i_t = \overline{r} + \overline{\pi}_t + \gamma_\pi(\pi_t^{(4)} - \overline{\pi}) + \gamma_y(y_t - y_{t-1}) + \epsilon_{it}.$$

The Government's budget constraint is given by

$$\begin{aligned} P_{Dt}G_t + TR_t = T_t + \tau_N W_t L_t + \tau_K(R_{Kt} + \delta P_{It})K_t \\ +\tau_{PO,t}P_{Ot}(O_t + O_{Ct}) + \tau_{QO}P_{Dt}(O_t + O_{Ct}) \\ +(MB_{t+1} - MB_t). \end{aligned}$$

Finally, lump-sum taxes T_t are adjusted each period to satisfy the government's budget constraint.

Calibration

Common Parameters

Parameter	**Used to Determine**	**Parameter**	**Used to Determine**
Parameters governing households' behavior			
$\beta = 0.997$	discount factor	$\chi = 10$	labor supply elasticity[a]
$\sigma = 2$	consumption elasticity[a]	$\varkappa = 0.8$	consumption habits
$\phi_I = 3$	investment adj. cost	$\phi_b = 0.001$	financial intermediation cost
Parameters governing firms' behavior			
$\rho = -2$	K-L substitution elasticity	$\delta = 0.025$	depreciation rate
$\theta_p = 0.20$	price markup	$\theta_w = 0.20$	wage markup
Parameters governing monetary policy			
$\gamma_\pi = 1.5$	infl. target elasticity	$\gamma_y = 0.5$	output growth elasticity

[a] The long-run intertemporal elasticity of substitution in consumption is $1/\sigma = 0.5$, while the Frisch elasticity is $2/\chi = 0.2$.

Calibration (continued)

Relative GDP Sizes

	ROW	Canada	Euro Area	U.S.
ROW	NA	21	2.4	1.4
Canada	0.048	NA	0.12	0.069
Euro Area	0.42	8.7	NA	0.61
U. S.	0.69	14	1.7	NA

Nominal GDP ratios(row over column), in U.S. dollars, averaged over 1997-2002.

Consumption, Investment and Government Shares of Output

	Consumption	Investment	Government Spending
ROW	0.56	0.17	0.28
Canada	0.51	0.17	0.32
Euro Area	0.57	0.17	0.26
U.S.	0.70	0.12	0.18

Calibration (continued)

Oil use (share of output) and tax rates

	Oil Use	Local Production	Ad-Valorem Oil Tax	Specific Oil Tax
ROW	0	1	0	0
Canada	0.045	1	0.07	0.25
Euro Area	0.02	0.1	0.2	0.4
U.S.	0.03	0.5	0.1	0.17

Calibration (continued)

Goods Imports, Oil Imports, and Total Imports Shares of Output

	Goods Imports	Oil Imports	Total Imports
ROW	0.12	0	0.12
Canada	0.40	0	0.40
Euro Area	0.14	0.018	0.16
U.S.	0.11	0.015	0.13

Imports of Goods as a Share of Output

	ROW	Canada	Euro Area	U.S.
ROW	NA	0.005	0.057	0.057
Canada	0.11	NA	0.018	0.27
Euro Area.	0.11	0.005	NA	0.025
U.S.	0.070	0.026	0.014	NA

Figure 1: Oil Price 2003

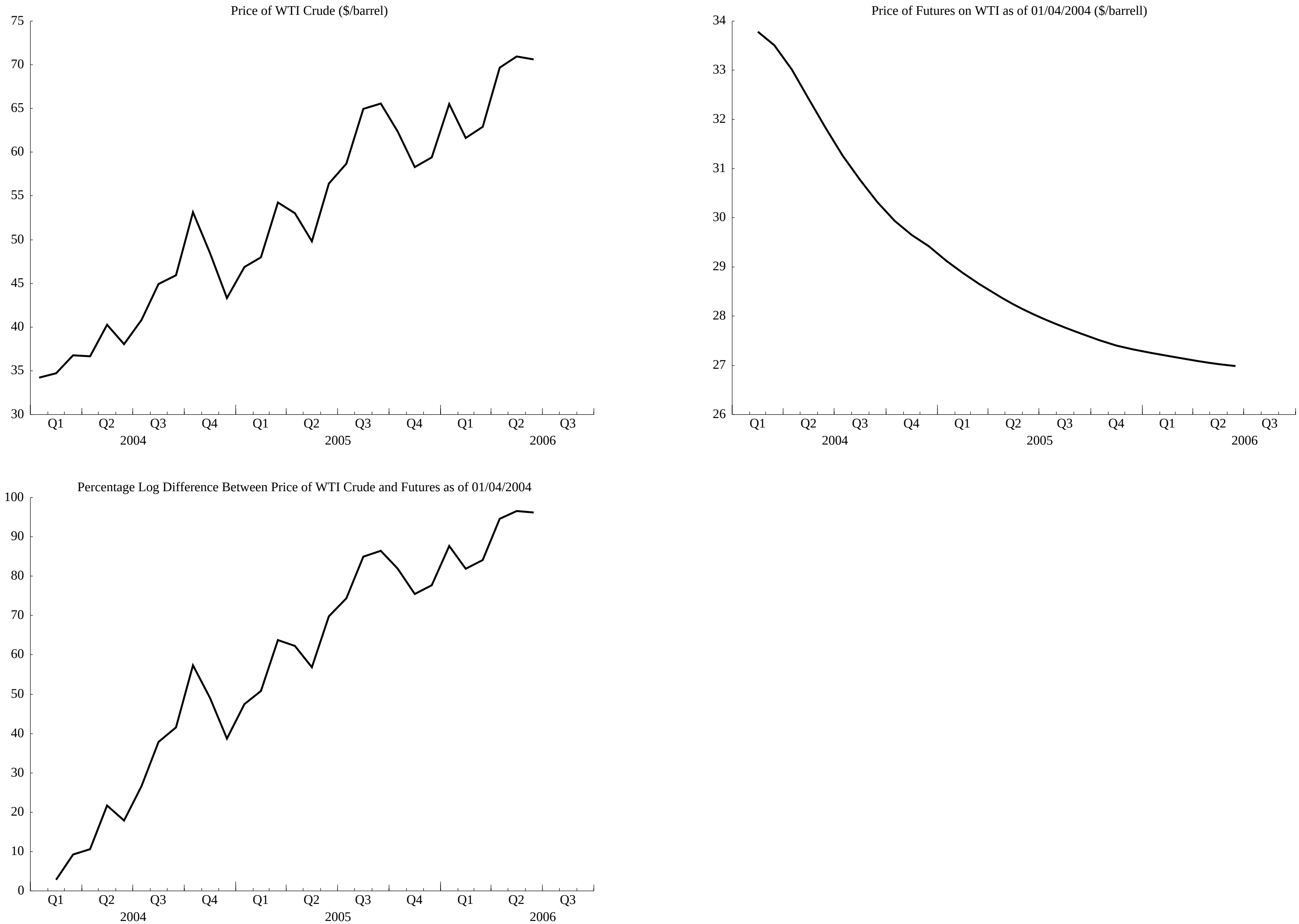
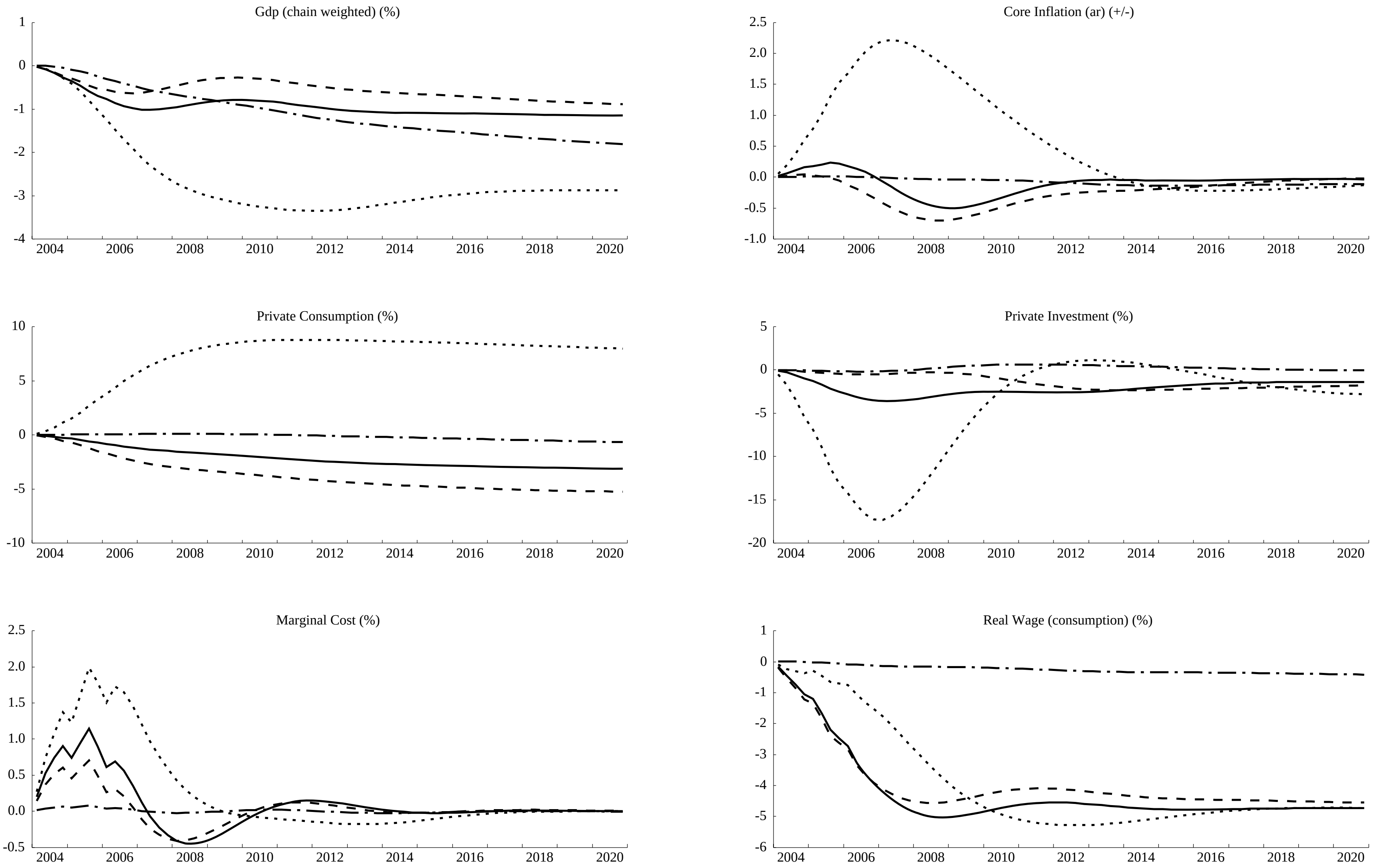
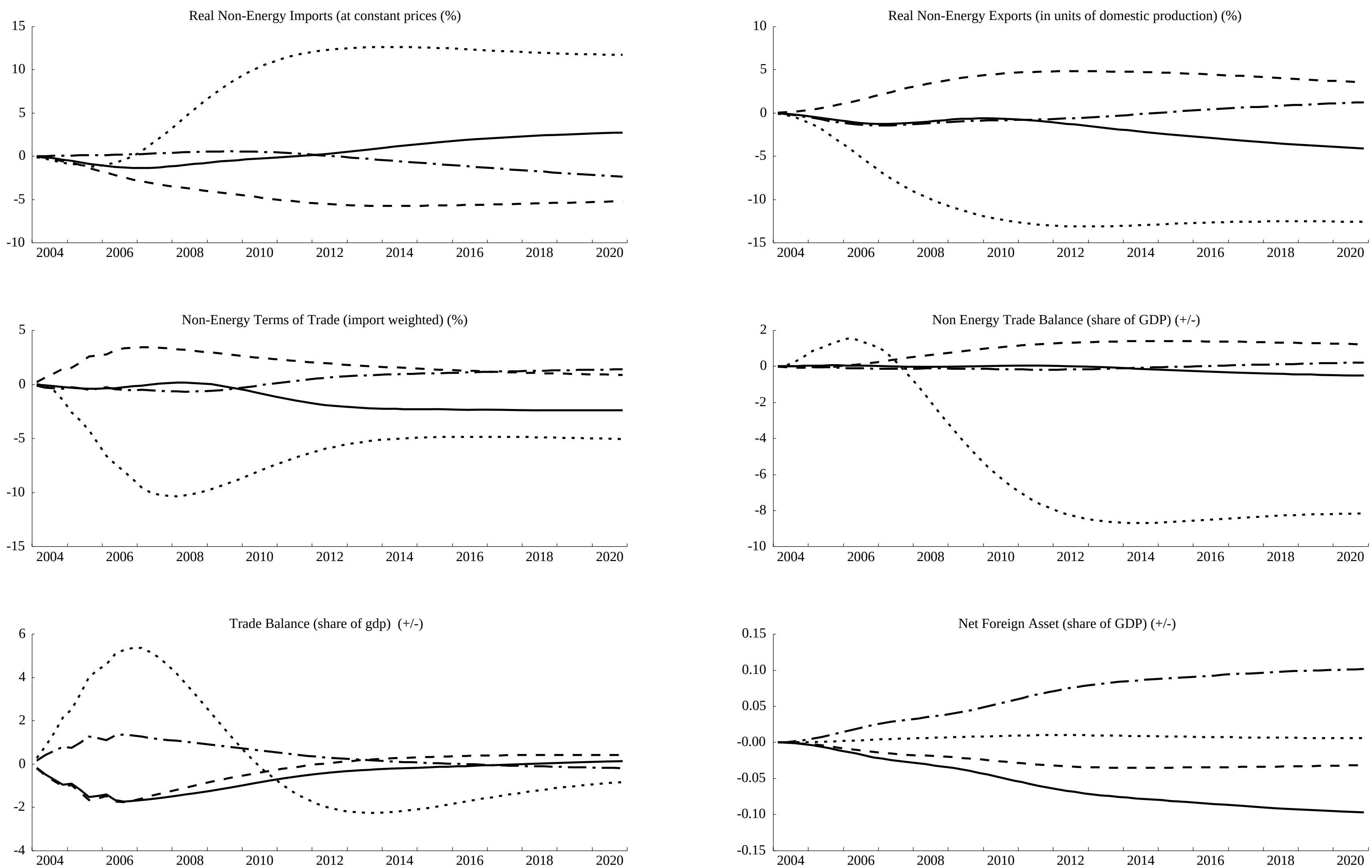


Figure 2: Oil Price Increases Since 2003
Absolute and Relative Deviation from Baseline



Solid: United_States
Dotted: Canada
Dashed: Euro Area
Dot-Dashed: ROW

Figure 3: Oil Price Increases Since 2003
Absolute and Relative Deviation from Baseline

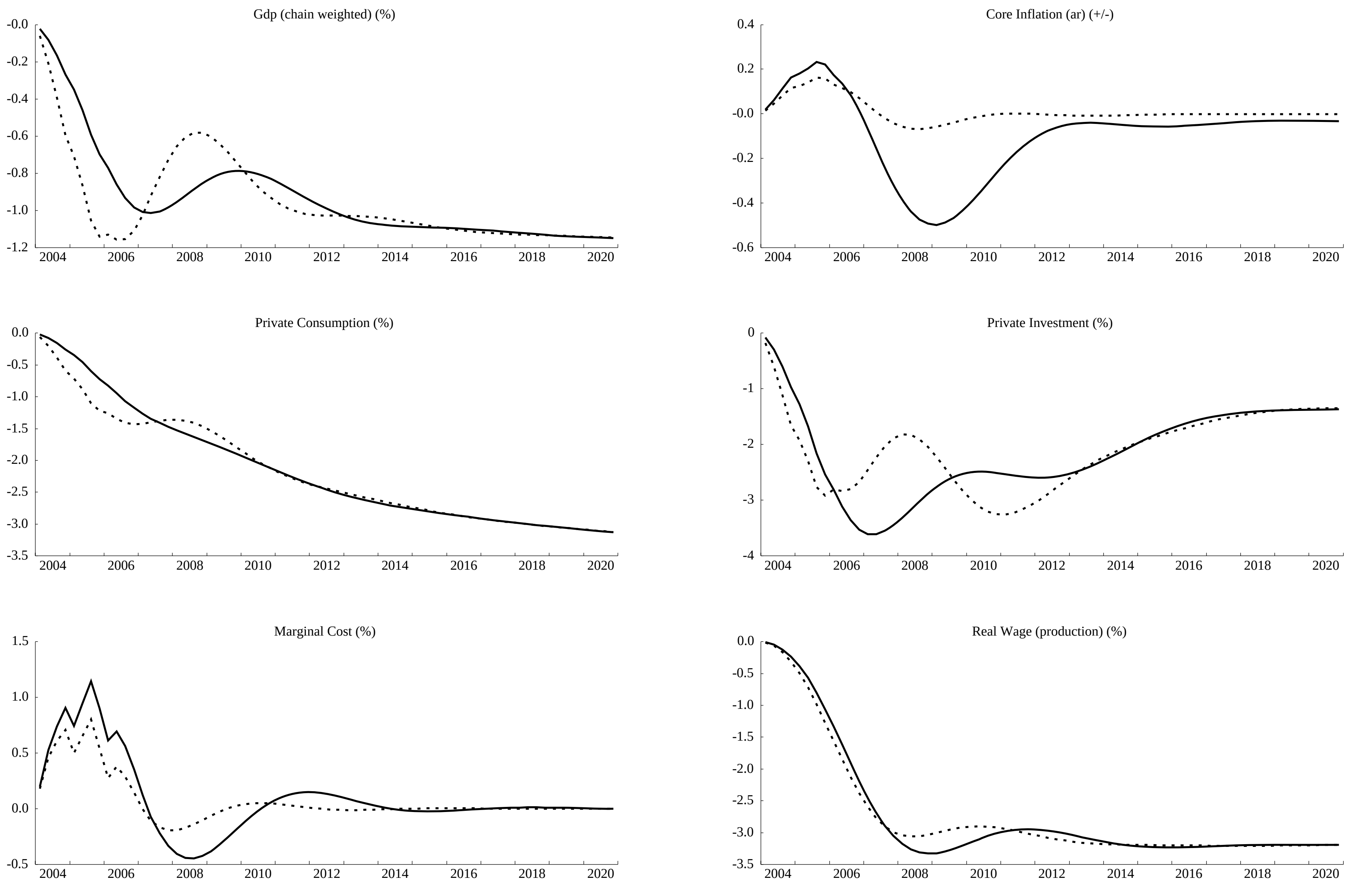


Solid: United_States
Dotted: Canada
Dashed: Euro Area
Dot-Dashed: ROW

Figure 4. Oil Price Increases Since 2003: Gauging the Effects of Alternative Monetary Policies

United States

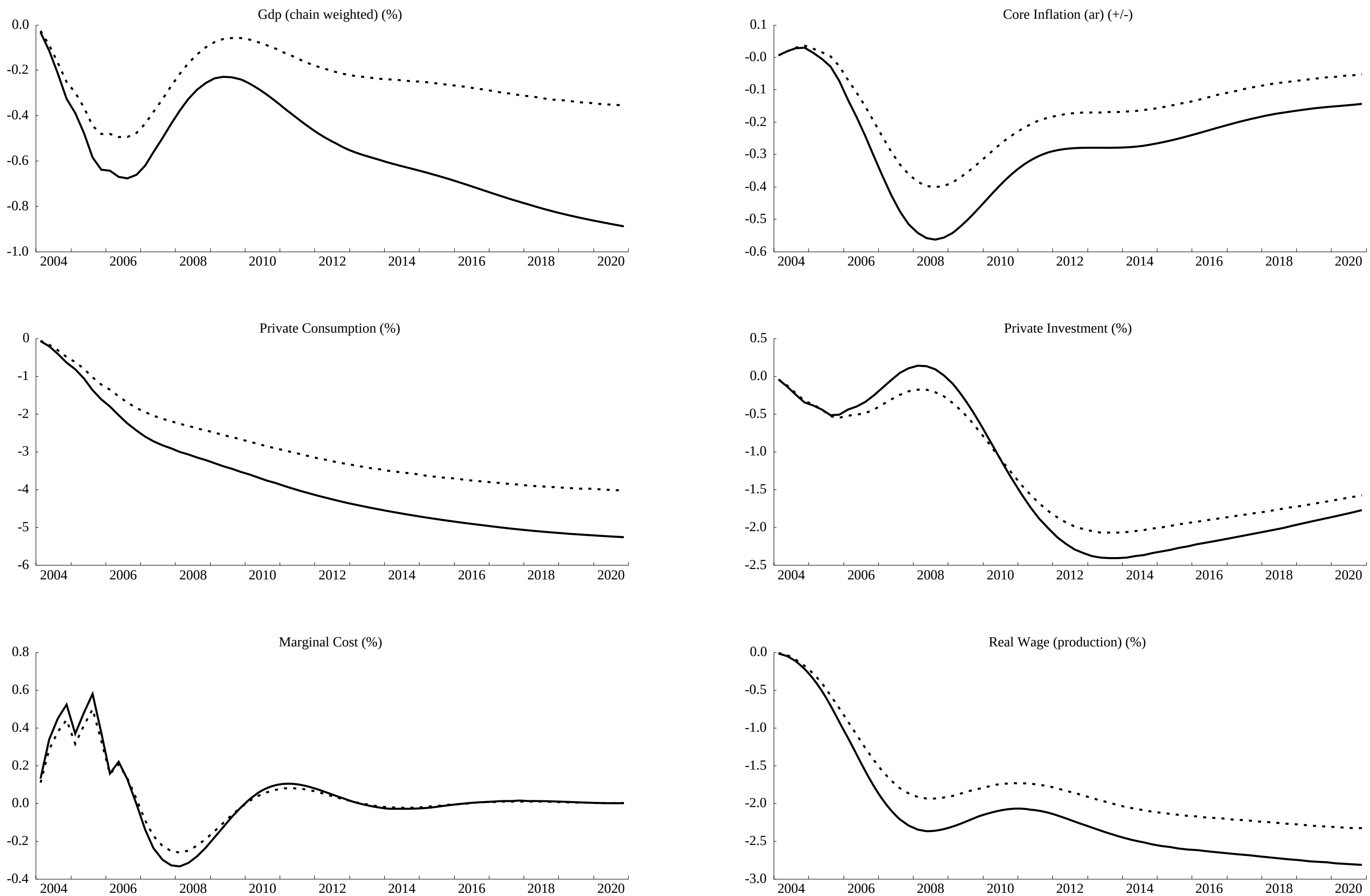
Absolute and Relative Deviation from Baseline



Solid: Baseline U.S. Response

Dotted: U.S. Response Under Core Inflation Targeting

Figure 5: Oil Price Increases Since 2003: Gauging the Effects of Energy Taxes
Euro Area
Absolute and Relative Deviation from Baseline



Solid: Baseline Euro Area Response
Dotted: Euro Area Response with No Energy Taxes

Conclusion

- Our baseline calibration implies little interaction between goods trade and oil trade for the United States.

- Local oil endowments generate profound cross-country differences in the reactions to oil shocks that emerge when international asset markets are incomplete.

- Lower values of the long-run elasticity of substitution for oil than in our baseline calibration would elicit greater interaction between trade in oil and trade in goods.

- SDGE models such as SIGMA can be a laboratory to interpret the growing empirical results on the impact of oil shocks across different countries, that are not based on fully-specified structural modelsh.

- We hope our work can highlight important transmission channels that the empirical studies ought to take into account.